DOCUMENT RESUME

ED 344 373 EC 301 100

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TITLE Right Hemisphere Deficit Syndrome: Similarities with Subtypes of Children with Attention Deficit Disorder (ADD).
PUB DATE Feb 92
NOTE 13p.; Paper presented at the Annual Convention of the International Neuropsychological Society (20th, San Diego, CA, February 5-8, 1992).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Adolescents; *Attention Deficit Disorders; *Brain Hemisphere Functions; Children; Classification; *Dyslexia; Educational Diagnosis; Elementary Secondary Education; *Handicap Identification; *Hyperactivity; Interpersonal Competence; Mathematics Achievement; Spatial Ability
IDENTIFIERS *Right Hemisphere Deficit Syndrome

ABSTRACT

Children with Attention Deficit Disorder (ADD) often exhibit problems in visual spatial perception, math achievement, and social skills, and it has been postulated that this constellation of behaviors may constitute Right Hemisphere Deficit Syndrome (RHDS). This study examined 21 children with attention deficit disorder with hyperactivity (ADD/H), 11 children with attention deficit disorder without hyperactivity (ADD/WO) and 10 children with dyslexia (LD) to determine if they could be differentiated on the basis of problem solving tasks that tap RHDS functions. Children's ages were between 6 and 16 years. Compared to LD children, ADD/H children scored significantly higher on the externalizing factor of the Child Behavior Checklist and the Math subtest of the Wide Range Achievement Test-Revised. On a judgment of line orientation test, ADD/H children exhibited significantly more right-sided errors whereas ADD/WO children demonstrated left-sided errors. Results provide limited support that ADD/H children exhibit problems similar to children diagnosed as Right Hemisphere Deficit Syndrome. Results also support the notion that ADD/WO children perform more similarly to LD children than to ADD/H children. (16 references) (JDD)

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RIGHT HEMISPHERE DEFICIT SYNDROME: SIMILARITIES WITH SUBTYPES OF CHILDREN WITH ATTENTION DEFICIT DISORDER (ADD)

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Presented at the 20th Annual Convention of the International Neuropsychological Society at San Diego, CA, February 8, 1992.

EC 301100

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Abstract

Children with Attention Deficit Disorder (ADD) often exhibit problems in visual-spatial perception, math achievement, and social skills, and it has been postulated that this constellation of behaviors may constitute Right Hemisphere Deficit Syndrome (RHDS). This study examined children diagnosed as ADD/H (n=21), ADD/WO (n=11) and LD (i.e., dyslexic, n=10) could be differentiated on the basis of problems tasks tapping RHDS functions. Compared to LD children, ADD/H children (i.e., not ADD/WO) scored significantly higher on the externalizing factor of the Child Behavior Checklist and the Math subtest of the WRAT-R. On Judgment of Line Orientation, ADD/H children exhibited significantly more right-sided errors whereas ADD/WO children demonstrated left-sided errors. Implications for applying the RHDS to understanding ADD/H are discussed.

Children with Attention Deficit Disorder (ADD) often exhibit problems in visual-spatial perception, math achievement, and social skills and it has been postulated that this constellation of behaviors may constitute a right hemisphere deficit syndrome (Brumback & Staton, 1982; Voeller & Heilman, 1988). The purpose of this study was to discern whether children diagnosed as Attention Deficit Disorder With Hyperactivity (ADD/H), Attention Deficit Disorder Without Hyperactivity (ADD/WO) and Learning Disabled (LD) could be differentiated on the basis of tasks measuring deficits related to the Right Hemisphere Deficit Syndrome. This model presumes a neuropsychological basis of ADD, and lends itself to viewing social skill problems as potentially having a neurological basis.

The notion that attention may be lateralized to the right hemisphere has recently been hypothesized by a number of researchers who have studied the relative performance of individuals with right hemisphere deficits or individuals who have attentional problems. In examining adult patients with anatomical disturbances of the right hemisphere, attentional deficits such as hemispatial neglect have been noted (Vallar & Perani, 1986). Adult patients with right parietotemporal lesions and neglect have shown less arousal when compared with patients with left hemisphere lesions with aphasia (Heilman, Schwartz, & Watson, 1978). Furthermore, adults and children with damage to the right hemisphere have been noted to have problems in vigilance, distractibility and performance of intentional motor activities (Heilman & Van Den Abell, 1980; Mesulam, 1981; Staton & Brumback, 1981). The literature with adult subjects implicates the right hemisphere as involved in the attentional processes.

Research has also been conducted on the characteristics of children with evidence of right-hemisphere dysfunction. Voeller and Heilman (1988) found that children diagnosed with ADD resemble adults with inattention and neglect secondary to right hemisphere dysfunction. Children with right parietal lobe syndrome often have difficulties in arithmetic and misperceive social situations with over- or under-emotional gestures, word usage, and tone of speech (Weinberg & McLean, 1986). Children who have been termed nonverbal perceptual-organizational-output disabled children are noted to have right hemisphere dysfunction as tapped by the WRAT arithmetic test. These children exhibited problems in spatial organization, misreading of visual detail, procedural errors, failure to shift operations, weak visual-motor skills, judgment and reasoning deficits, and attending to and interpreting nonverbal social cues such as gestures and facial expressions (e.g., Ozols & Rourke, 1985; Rourke, 1982; Strang & Rourke, 1983, 1985).

In examining the behavioral, neurological, and neuropsychological characteristics of children with evidence of right-hemisphere dysfunction, Voeller (1986) found that 93% of the children had ADD, and 8 of the children were withdrawn or isolated. She noted that 7 of the children "could not grasp the nuances of social situations" (pp. 1006), which resulted in inappropriate behaviors in social settings and frequent fighting. Ternes, Woody, and Livingston (1987) presented a case report of a child with right hemisphere deficit and noted his difficulties in arithmetic and spelling achievement, social problems, withdrawal, lethargy, and right temporal spikes on an EEG.

In this study, it was predicted that the ADD groups would demonstrate problems on visual-spatial tasks, math achievement, and socioemotional measures whereas the LD group would not demonstrate such deficits. Furthermore, it was expected that children diagnosed as ADD/H would demonstrate difficulties on tests that measure sequential, cognitive operations that are presumed to be indices of anterior or frontal lobe functioning (i.e., Trails B, Digit Span subtest of the WISC-R, and Coding subtest of the WISC-R) as well as exhibit externalizing disorders and social problems of an acting-out nature (i.e., Achenbach externalizing dimension and classroom sociometric). Conversely, it was expected that children diagnosed as ADD/WO would demonstrate problems on tests measuring visual-spatial abilities, especially those measuring posterior or parietal lobe functioning (i.e., Beery Tests of Visual-Motor Integration, Benton Line Orientation, Test of Facial Recognition, Block Design subtest of the WISC-R, and Math subtest of the WRAT-R). ADD/WO children were also expected to exhibit internalizing disorders and social problems exemplary of withdrawn behaviors (i.e., Achenbach internalizing dimension, and sociometric). Finally, it was proposed that LD children would not exhibit difficulty with any of the aforementioned tasks as their deficits are presumed to be linguistic and lateralized to the left hemisphere. The measures chosen were selected for their minimization of linguistic components. Previous related studies that used measures with a substantial linguistic loading (i.e., Luria-Nebraska) have found nonsignificant results (e.g., Lorys, Hynd, & Lahey, 1990).

Method. Three groups were compared; namely, ADD/H (n=21), ADD/WO (n=11), and LD (i.e., dyslexic, n=10) children. The clinic control group of reading disabled (i.e., dyslexic) children, with no secondary diagnoses, was not derived from the ADD groups. The clinic control children were hypothesized to have deficits in linguistic functioning, reflective of left hemisphere dysfunction. Children were between 6 to 16 years of age, with both sexes included and all socioeconomic levels represented. Diagnostic criteria, based on DSM-III criteria, was based on the K-SADS.

Results. Preliminary analysis on the total sample was conducted on the neuropsychological measures that were not age-corrected and also for the achievement measure that was expected to correlate with WISC-R Full-Scale IQ. An analysis of variance was performed to study the difference between groups. However, on all measures in which age and neuropsychological test were correlated, an analysis of covariance (ANCOVA) was used. In addition, the correlation between WISC-R Full Scale IQ and WRAT-R Math subtest was significant, and an ANCOVA was used to study these results. Planned comparisons using the Newman-Keuls procedure corrected for unequal cell sizes were used.

On the psychometric measures, insignificant results were found on all three planned comparisons of the subtests of the WISC-R and the Beery Tests of Visual-Motor Integration (VMI), with the ADD/WO group scoring the highest followed by the LD and then the ADD/H group.

On the socioemotional measures, the teacher Achenbach Sum-T was significant [$F(2,38)=4.15$, $p<.05$] as was the Achenbach externalizing-T [$F(2,38)=6.61$,$p<.01$]. Pairwise comparisons for the Achenbach Sum-T indicated that the ADD/H group ($\underline{Ms}=66.14$) scored higher than the LD group ($\underline{Ms}=57.00$). Pairwise comparisons for the Achenbach externalizing-T indicated that the ADD/H group ($\underline{Ms}=67.52$) scored higher than the LD group ($\underline{Ms}=56.90$). In both comparisons the ADD/WO children obtained mean scores inbetween the ADD/H and LD groups. These results were in the expected direction. The sociometric did not yield significant differences between the groups.

On the visual-spatial measures, insignificant results were obtained for most measures. However, the measure Judgment of Line Orientation in which the subject's right-sided versus lift-sided errors were contrasted yielded significant results [$F(3,31)=3.98$,$p<.05$]. In examining the group means, the ADD/H children exhibited the most right-sided errors whereas the ADD/WO children demonstrated the most left-sided errors. Also, on the Math subtest of the WRAT-R, a significant group effect was obtained [$F(3,13)=4.01$,$p<.05$]. Pairwise comparisons on this measure indicated that the ADD/H group ($\underline{Ms}=91.13$) scored higher than the LD group ($\underline{Ms}=76.00$). These results were also in the expected direction.

Discussion. This study provided limited support that ADD/H children exhibit problems similar to children diagnosed as Right Hemisphere Deficit Syndrome. In particular, differences between ADD/H and LD children (i.e., not ADD/WO) were noted on one visual-spatial measure and one socioemotional measure. In this study, the visual-spatial measure was utilized as a measure of hemi-inattention, or neglect. Results from this study support the notion that ADD/WO children perform more similarly to LD children than to ADD/H children. This finding is consistent with other research (Hynd et al., 1991) that found a 60% concordance rate between ADD/WO and LD children but no concordance (i.e., 0%) between ADD/H and LD children. Given the difference in errors between the ADD/H and children on the measure of hemi-inattention, it appears that ADD (i.e., ADHD as classified in DSM-IIIR) is not simply a right-hemisphere dysfunction but involves a number of different brain systems, possibly implicating different functional systems related to spatial attention in children with ADD/H and ADD/WO. In summary, the Right Hemisphere Deficit Syndrome may relate differentially to subtypes of ADD and provide important cues to the neuropsychological basis of ADD.

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ADD/H, ADD/WO, and LD Subjects
Group Means and Standard Deviations for all Measures

Test	ADD/H (n=21) $\overline{X}$ (SD)	ADD/WO (n=11) $\overline{X}$ (SD)	LD (n=10) $\overline{X}$ (SD)
WISC-R			
Digit Span	9.24	9.64	8.90
	(2.77)	(3.17)	(3.04)
Coding	7.80	7.18	8.60
	(3.30)	(2.23)	(3.44)
Block Design	9.76	10.18	11.80
	(3.74)	(2.99)	(3.33)
Teacher Achenbach			
Sum T	66.14	63.50	57.00
	(8.71)	(7.12)	(8.31)
Internalizing T	58.95	62.10	55.20
	(8.20)	(6.17)	(7.44)
Externalizing T	67.52	63.30	56.90
	(8.30)	(6.67)	(6.92)
Sociometric			
Liked Most	11.00	13.29	16.14
	(17.77)	(13.04)	(8.55)
Liked Least	29.18	21.57	16.57
	(30.90)	(27.38)	(15.36)
Fights Most	11.64	11.43	12.00
	(16.28)	(11.76)	(8.87)
Meanest	20.36	6.86	11.29
	(22.83)	(5.37)	(8.04)
Most Shy	7.73	11.43	14.86
	(19.04)	(11.75)	(10.76)
Beery Test of Visual-Motor Integration	7.00	7.80	7.56
	(3.54)	(4.32)	(2.51)
Judgment of Line Orientation (Formula)	-.20	.18	-.09
	(.36)	(.48)	(.16)
Judgment of Line Orientation (# correct)	18.00	17.60	14.25
	(8.94)	(5.48)	(6.50)
Facial Recognition	39.05	39.70	35.11
	(6.69)	(5.06)	(9.39)
Trails B	77.33	63.40	100.89
	(61.44)	(30.31)	(63.71)
WRAT-R: Math subtest	91.13	84.25	76.00
	(13.73)	(11.09)	(13.60)

ADD/H, ADD/WO and LD Subjects
Group Size and Planned Comparisons Results for Measures with Age-Corrected Scores

Test	ADD/H (n)	ADD/WO (n)	LD (n)	F-test	DF	p value
WISC-R						
Digit Span	21	11	10	.17	(2,39)	.85
Coding	20	11	10	.55	(2,38)	.58
Block Design	21	11	10	1.19	(2,39)	.32
Teacher Achenbach						
Sum T	21	10	10	4.15	(2,38)	.02*
Internalizing T	21	10	10	2.08	(2,38)	.14
Externalizing T	21	10	10	6.61	(2,38)	.00*
Sociometric						
Liked Most	11	7	7	.27	(2,22)	.77
Liked Least	11	7	7	.51	(2,22)	.61
Fights Most	11	7	7	.00	(2,22)	1.00
Meanest	11	7	7	1.63	(2,22)	.22
Most Shy	11	7	7	.47	(2,22)	.63
Beery (VMI)	20	10	9	.19	(2,36)	.83

* $p < .05$

ADD/H, ADD/WO and LD Subjects
Group Size and ANCOVA Results for Each Measure with Age as a Covariate

Test	ADD/H (n)	ADD/WO (n)	LD (n)	df	Interaction Effect F value	Interaction Effect P value	Age Effect F	Age Effect P	Group Effect F	Group Effect P
Judgment of Line Orientation (formula)	18	10	7	(3,31)	.37	.69	6.12	.02	3.98	.03
Judgment of Line Orientation (# correct)	20	10	8	(3,34)	1.05	.36	13.79	.00	.12	.89
Facial Recognition	21	10	9	(3,36)	.06	.94	4.99	.03	.71	.50
Trails B	21	10	9	(3,36)	.49	.62	14.41	.00	.51	.60

* $p < .05$

Group Size and ANCOVA Results for Each Measure with IQ as a Covariate

Test	ADD/H (n)	ADD/WO (n)	LD (n)	df	Interaction Effect F value	Interaction Effect P value	Age Effect F	Age Effect P	Group Effect F	Group Effect P
Trails B	12	4	7	(5,17)	.97	.40	11.86	.00	1.04	.37
WRAT-R: Math subtest	8	4	7	(3,15)	.19	.83	5.27	.04	4.01	.04

* $p < .05$